Jones & Laughlin Steel Corp.

Fire is essential in various industrial processes, particularly the manufacture of steel. Intense flames melt scrap iron, iron ore, and other raw materials in an open-hearth furnace to produce molten steel, *left.*

FIRE. The earliest use people made of fire was to keep warm. As civilizations advanced, people learned to use fire in many other ways. Even in earliest times, people had learned to use fire to cook food, to shape weapons and tools, to change clay into pottery, and to furnish light. But primitive peoples had very slow and unsatisfactory ways of kindling fires. Today, people have not only improved the methods of kindling fires, but they also use fire in many more ways. Fire furnishes the energy to drive machines, and keeps vast industries running. It supplies the power to drive trains, ships, and planes; and it generates electricity. Fire is used to remove and destroy waste materials and to kill harmful bacteria.

Fire is also used in separating most metals from their ores, as well as in forging and shaping metals into useful things. Many chemical changes of materials are either made possible or speeded up by the use of fire. A few of these chemical changes are made in such places as sugar refineries and petroleum plants.

Controlled fire is useful. Uncontrolled fire kills thousands of people and destroys millions of dollars' worth of property each year.

What Is Fire?

Fire is the heat and light that comes from burning substances. In 1777, Antoine Lavoisier, a French chemist, proved that burning is the result of the rapid union of oxygen with other substances (see LAVOISIER, ANTOINE L.). As a substance burns, heat and light are produced. Burning is also called *combustion.* Often oxygen unites with other substances at such a slow rate that little heat and no light are given off. When this happens, we call the process *oxidation,* rather than *burning* or *combustion.* Oxidation takes place whenever oxygen unites with other substances either rapidly or slowly. For example, when oxygen unites with gasoline, the action takes place rapidly and heat and light are given off. This process may be described by any of the three words, burning, combustion, or oxidation. When oxygen unites with iron and causes it to rust, burning, or combustion, does not take place, but oxidation does.

Kinds of Fire. All substances do not burn in the same manner. Charcoal, for example, gives off heat with a faint glow. But other substances, such as coal, gas, magnesium, oil, and wood, give off heat with a flame. The color of the flame depends chiefly on the kind of material being burned and on the temperature.

Substances may burn in different ways, but they all require oxygen to burn. Sometimes old rags soaked with oil or paint are thrown aside and forgotten. Oxygen from the air may slowly unite with the oil in the rags. At first, there will not be a fire. But as oxidation gradually takes place, enough heat accumulates to set the rags on fire. This type of burning, called *spontaneous combustion,* causes many fires.

Very rapid burning may cause explosions like those produced by gunpowder and dynamite. Here, oxidation takes place so rapidly that great volumes of gases are produced. These require many hundreds of times the space that was formerly occupied by the gunpowder or dynamite before it was oxidized. These gases expand so rapidly and violently that they produce an explosion. An explosion is really a sudden increase in volume, caused by rapid burning.

How Fire Is Produced. Three conditions must exist before a fire can be made. There must be a fuel or a substance that will burn. The fuel must be heated to its *kindling temperature.* This is the temperature at which oxygen will rapidly unite with the fuel. Finally, there must be plenty of oxygen, which usually comes from the surrounding air.

Fuels are of three classes, solids, liquids, and gases. Coal and wood are examples of solids. Oil and gasoline are liquid fuels. Natural gas and hydrogen are gaseous fuels.

The burning of a solid fuel often depends upon its form. For example, you may not be able to light a large log with a match, but a small twig from the same tree may catch fire easily with the same match. This is because the twig has more air (oxygen) available in proportion to the wood that is to be burned. This explains why it is easy to start a fire with splinters or shavings. Also, the kindling temperatures of fuels differ. Some,

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Methods of Making Fire. In ancient times, people twisted sticks in holes in wood until friction caused flames. They also struck rocks together to create sparks. Today, matches ignite when their heads, made of chemicals, are struck on rough surfaces.

such as dry wood or gasoline, have a low kindling temperature, and we can easily set a fire to them. Others, such as hard coal and coke, have a high kindling temperature and are difficult to ignite. A substance known as phosphorus has such a low kindling point that it will start burning in the air at normal temperatures. It must be placed under water in order to keep it from burning. Sodium is another substance that has a low kindling point. It will even burn in water, by taking the oxygen from the water. In order to keep sodium from burning, it has to be placed in kerosene.

If the kindling temperature of a fuel is high, we may place the fuel in a fire already going, as we often do in firing a furnace or stove. We may apply the fire to the fuel as we do with matches when we start a fire. We may produce the kindling temperature of a substance by rubbing it over another substance by *friction*. The early Indians rubbed sticks together to start a fire.

The supply of oxygen for a fire is usually taken from the air, since air is about one-fifth oxygen. If enough oxygen is not available, we often fan the fire to move more air to it. The oxygen supply to furnaces is regulated by openings which can be closed with check drafts. In locomotives and large boilers, air is often forced to the fuel by blowers.

Fireproof Materials. Substances that will not burn easily are called fireproof materials and are used in fireproofing.

There are two reasons why they will not burn easily. Some fireproofing materials have already combined with as much oxygen as possible. Others will not unite with oxygen at ordinary temperatures. Examples of fireproof materials are asbestos, sand, brick, and stone. Metals like steel and copper are considered fireproof because they combine with oxygen very slowly except at higher temperatures than those which ordinary flames produce.

Methods of Starting Fires. There are several methods of starting a fire, but in each of them the three necessary conditions for a fire must be present. Before matches were invented, the flint and steel method was used. This method required a piece of steel, a flint (hard rock), and a tinder. The tinder was generally made from cotton or linen cloth, or from dried, powdered bark from certain trees. It was heated in an oven until it was nearly ready to burn. It was then placed in a tinderbox to keep it perfectly dry. When the fire was to be started, tinder was placed on the ground and the flint struck against the steel. Some of the sparks made by the flint and steel would fly into the tinder and light it.

Another early method of starting fires was by friction. This method consisted of whirling a stick in a notch in a board until the wood powder that was produced began to glow. Enough oxygen to turn the glow into a blaze was supplied by blowing carefully on the glowing powder.

The first match was invented in 1827 by the English pharmacist John Walker. The tip of this match was

KINDLING TEMPERATURES OF COMMON MATERIALS

Kindling temperature, or kindling point, is the temperature to which a substance must be heated to burst into flame. Every burnable substance has its own kindling temperature. The lower the kindling temperature, the more easily a substance will catch fire.